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New Jersey Greenhouse Gas Emissions Inventory and Projections

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Background

A number of gaseous substances are considered greenhouse gases because they trap heat in the atmosphere in a manner analogous to the way a greenhouse traps heat. These gases include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perflourocarbons (PFCs), and sulfur hexafluoride (SF_6). Water vapor concentrations in the atmosphere are not directly influenced by human activity. The other gases, with the possible exception of methane, are rapidly building in the atmosphere due to anthropogenic emissions; their warming effect is already being felt and is projected to accelerate, perhaps dramatically, if emissions are not curbed. New Jersey's new law, the Global Warming Response Act (the Act), defines all of the above (except water vapor) as greenhouse gases, and also includes "any other gas or substance determined by the Department of Environmental Protection to be a significant contributor to the problem of global warming." This definition permits the expansion of the list to include such substances as black carbon, ground level ozone and other heat-trapping pollutants should it be determined that they are significant contributors.

The Act sets greenhouse gas emission limits for 2020 and 2050, directs the Department to establish an inventory of 1990, current, and 2006 statewide greenhouse gas emissions, and to adopt rules and regulations establishing a program to monitor and report statewide greenhouse gas emissions. The Department is also to report by January 1, 2009, and biennially thereafter, the status of the greenhouse gas emissions monitoring and reporting program, the current level of greenhouse gas emissions in the State and the progress made toward compliance with the limits. The law makes it clear that the emissions monitoring and reporting program is to include data on electricity generation as well as sales of fuels including natural gas, gasoline, heating oil, etc., and can include data from "any additional entities that are significant emitters of greenhouse gases."

Greenhouse Gas Emissions and Monitoring Information and Estimates

Current methods of estimating greenhouse gas emissions in the U.S. rely on one primary source of information, the U.S. Department of Energy, Energy Information Administration (EIA). Using a well-established procedure that appears to be consistent from year to year, the EIA surveys a subset of fuel merchants and estimates sales and consumption of fuels. It also keeps track of electricity sales. It makes these data available at a statewide level, typically at least two years after the present date (e.g. the complete 2004 data was released June 1, 2007; complete 2006 data is expected to be released November, 2008). Translating fuel use data to CO_2 emissions is straightforward. It is necessary to know only the carbon content of the fuel; combustion transforms virtually all of a fuel's carbon to CO_2 (some CO is formed during combustion, but this oxidizes rapidly in the atmosphere to CO_2). Certain amounts of CH_4 and N_2O are also formed during combustion. Since these gases, molecule for molecule, are much more powerful greenhouse gases, these emissions are not insignificant from some combustion sources, e.g. automobiles. The USEPA has made a tool available for states, the State Greenhouse Gas Inventory tool, that facilitates the translation of EIA data to greenhouse gas emissions estimates, and which includes emission factors for CH_4 and N_2O.

Significant emissions of CH_4 also occur from landfills and other situations where anaerobic decomposition takes place, such as digestion of wastewater treatment plant sludge. N_2O is emitted from soils under some conditions, and also from a variety of other sources. Halogenated gases (HFCs, PFCs, and SF_6) are emitted from a variety of sources, including aluminum manufacture, electronics manufacture, air conditioning and refrigeration systems. The major halogenated gas emitted in New Jersey is HFC-134a. This gas, used in automobile air conditioners and in some other applications, is the primary replacement for the ozone-depleting CFC-12, the production of which is banned through international agreement. Utilities release significant amounts of SF_6, which is used as an insulating gas to prevent electric arcing in switching stations.

Like CO_2, emissions of these other greenhouse gases have so far been estimated using models or algorithms that are likely to contain uncertainty and that are based on sales and other activity data which are typically several years old. New Jersey does require submission of CO_2 and CH_4 emissions figures from approximately 300 relatively large facilities that are regulated under the Department's Emissions Statement Program.

CO_2 is also captured by plants. Forests sequester relatively large quantities of CO_2, especially when they are actively growing. When forests are cleared, assuming they are not replanted, a one-time release of CO_2 occurs as much of the carbon they contain in the form of cellulose and lignin is relatively rapidly oxidized. As with the non-CO_2 greenhouse gases, a number of approaches exist for estimating loss of carbon through land clearing and for sequestration by forests.

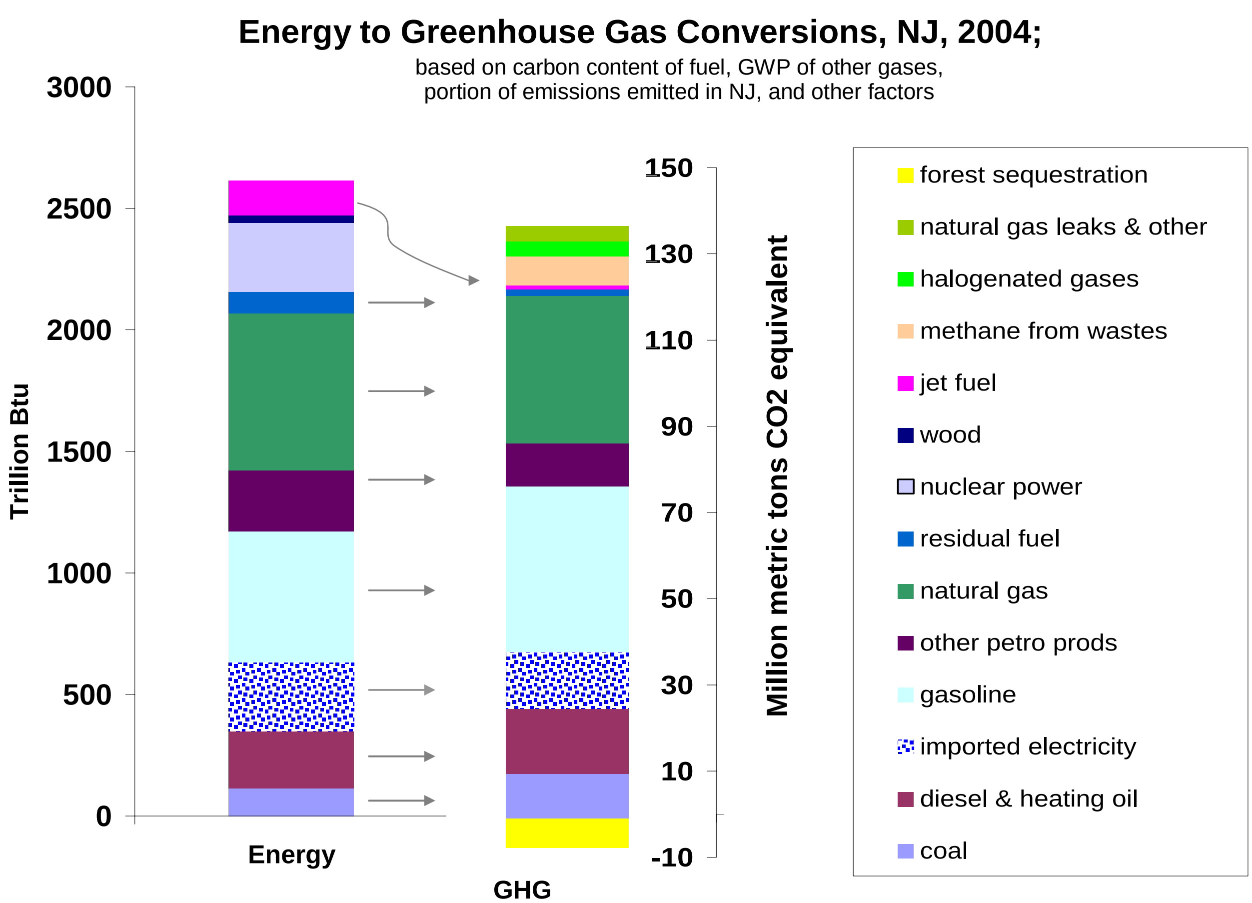
The lack of redundancy and independent means of confirming emissions estimates, coupled with the need to rely on emission factors in many cases, suggests that there may be considerable uncertainty. Comparison of presumably directly related datasets where such exist has shown mixed results. For example, New Jersey Emissions Statement data for the in-state electricity generation sector is consistent with data derived through EIA. On the other hand, two different EIA datasets relevant to determining out-of-state emissions associated with the electricity imported to New Jersey yield estimates that differ by 15 percent.

The reporting program to be developed by the Department pursuant the Global Warming Response Act should improve both the accuracy and timeliness of greenhouse gas emissions estimates in New Jersey because it will be based on required submission of relevant data.

Existing estimation approaches, applied to New Jersey by the Department's Division of Science, Research & Technology, with the assistance and advice of the Center for Climate Strategies (CCS) and the Department's Bureau of Air Quality Planning, have yielded estimates that are believed to present a reasonably accurate picture of 1990 and 2004 greenhouse gas emissions in the state. Methods used by the New Jersey Board of Public Utilities (BPU) in conjunction with researchers at Rutgers University, coupled with projection methods provided by CCS, permit the approximate determination of 2020 emissions both without any reductions (business as usual) and with the emissions reductions expected due to the various actions either underway or planned to be implemented by the BPU through the Energy Master Plan and by other programs including the Regional Greenhouse Gas Initiative (RGGI) and the implementation of the California Low Emission Vehicle (LEV) program in the state.

Figure 1 shows the energy use information as supplied by EIA and the transformation of these fuel use and other activity data to New Jersey greenhouse gas emission estimates. These transformations take into consideration the carbon content of the fuel and the global warming potential of the gases. The calculations also count only that portion of the fuel consumption or other activity that takes place in, or is directly under the control of New Jersey.

Figure 1



It can be seen from this chart that nuclear power and combustion of wood (presumed to be grown in a sustainable manner) are considered to result in virtually non-existent greenhouse gas emissions. It is also apparent that jet fuel and residual fuel are estimated to not contribute greenhouse gas emissions proportionate to their share of the energy mix; this is because much of the combustion of these fuels occurs in national or international flights or by ocean-going vessels outside of the jurisdiction of the state.
Figure 1 depicts the estimated emissions of halogenated gases. (Note that the emissions of ozone-depleting gases, now controlled by international treaty, are not shown. These gases have very high global warming potential. However, by the late-90s, their emissions had dropped to the point where they were relatively small contributors to overall greenhouse gas emissions.) The figure also shows various non-combustion CO_2 and other emissions, which include certain industrial emissions of CO_2 (e.g. from the production of adipic acid) and emissions of CH_4 from natural gas transmission and distribution systems. Also included in this category are emissions of CO_2 associated with the one-time clearing of forests, primarily for construction of buildings, parking lots, etc. Estimated emissions of CH_4 from in-state landfills, and the similar emission from NJ waste disposed in out-of-state landfills, are also depicted. The sequestration of carbon (converted to CO_2 equivalent) by growing plants, primarily forests, is also shown. Since this represents a reverse flow of CO_2, it is charted as a negative number.

The data can be broken down by sector. Figure 2 shows the 2004 estimates apportioned in this way.

Figure 2

Greenhouse Gas Emissions by Sector; New Jersey, 2004
Millions of metric tons CO_2 equivalent

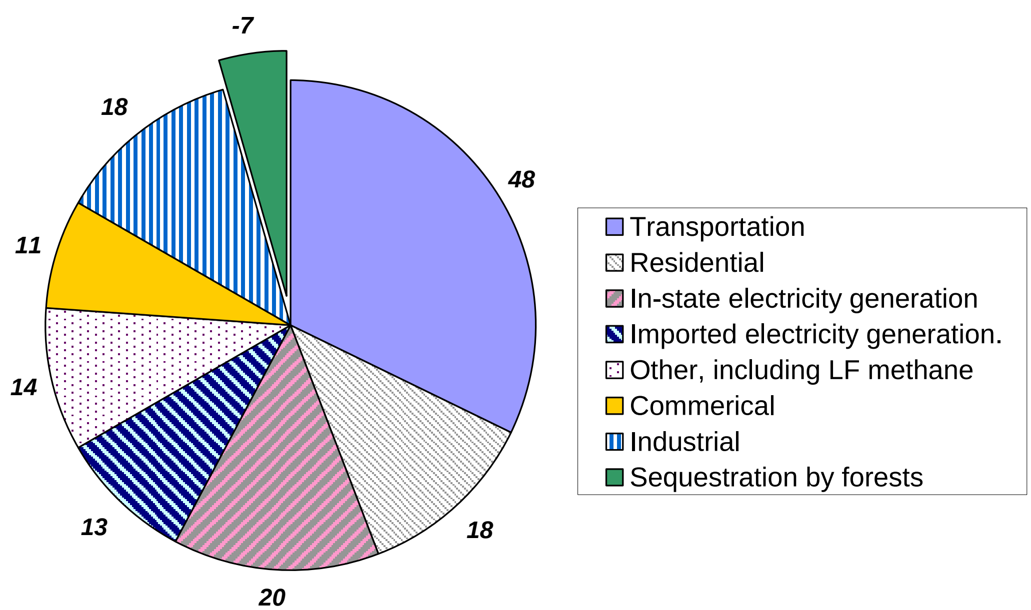


Figure 3 shows major sectors with their portion of electricity use included.

Figure 3

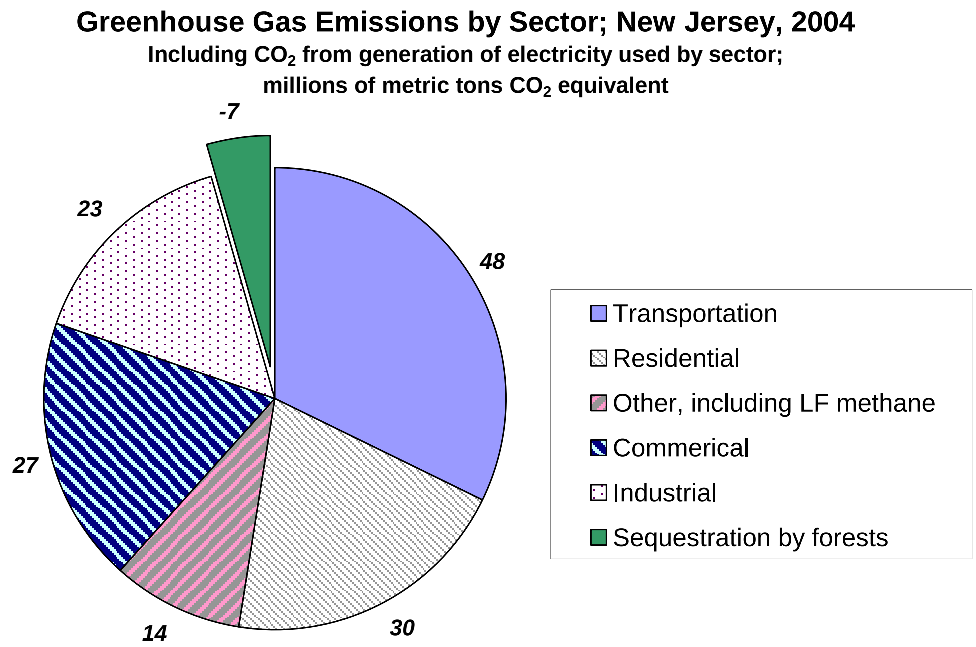


Figure 4 shows the 1990 through 2004 trend of major sectors or combined sectors.

Figure 4

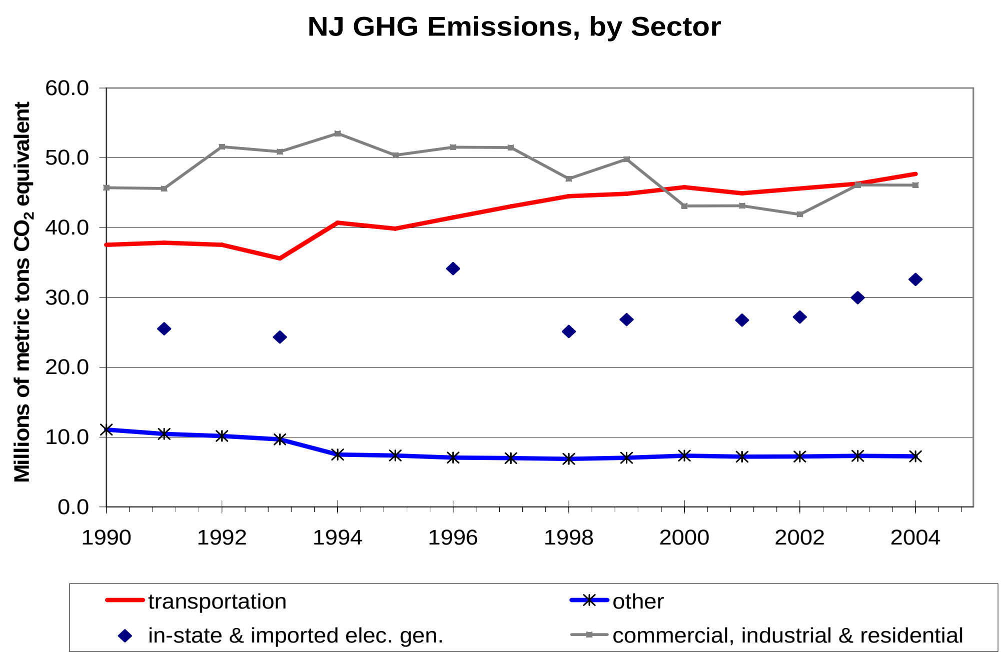


Figure 4 illustrates year-to-year variability which is particularly pronounced for the electricity generation sector and for the combined commercial, industrial, and residential sector. Variation in the former has a lot to do with the utilization rate of New Jersey's nuclear power plants. When these facilities are not operating at full capacity, as was the case in the mid-90s, more electricity is imported. Since much of the imported electricity is produced by the combustion of coal, emissions were higher in those years. Variation in the commercial/industrial/residential sector is related to both economic activity and the weather. In years with a cold winter and/or a hot summer, energy use by buildings increases. The long-term downward trend in the "other" sector is due in part to the gradual decline in emissions of CH_4 from in-state landfills. These facilities once received relatively huge quantities of out-of-state waste; much of this material has now decomposed and as a result CH_4 emissions are dropping.

Projections to 2020

A variety of approaches, using information, data, and methods provided by CCS, the BPU, and Department staff, were used to project emissions in 2020 that would occur if no reduction actions were taken, and that are expected to result in 2020 through the Energy Master Plan and associated efforts, such as implementation of RGGI and the motor vehicle LEV standards. These estimates are shown in Table 1, which also shows the estimated 1990 emission.

Table 1. New Jersey Greenhouse Gas Emissions; Estimates and Projections; Millions of Metric Tons CO_2 Equivalent

Sector	**Sub-sector**	**2004**	**2020 BAU**	**2020 w. planned actions**	**Comments**
Transportation	On-road gasoline	37.9	44.3	31.3	projections sensitive to VMT growth
	On-road diesel	7.3	11.0	10.5	projections sensitive to VMT growth
	Aviation	1	1	1	primarily jet fuel, estimated in-state use; total is ~ 8 tons
	Marine	1.3	1.8	1.8	diesel & residual; does not include port expansion
	Railroad & Other	0.5	0.6	0.6	
Electricity	In-state	19.0	21.5	18.7	2020 w. actions set equal to RGGI cap
	In-state, from MSW	1.3	1.3	1.3	
	Imported	13.4	20.3	4.8	2020 w. actions is minus out-of-state renewables from RPS
Residential	Space heat	14.2	15.5	12.4	20% reduction through EMP
	Other combustion	3.4	3.8	3.0	20% reduction through EMP
Commercial	Space heat	6.1	5.7	4.6	20% reduction through EMP
	Other combustion	4.8	3.6	2.9	20% reduction through EMP
Industrial	Space heat	0.7	0.4	0.3	20% reduction through EMP
	Other combustion	17.1	15.3	13.9	9% reduction through EMP
Halogenated gases (ex. SF_6)		3.4	8.4	8.4	
SF_6		0.3	0.1	0.1	
Industrial non-fuel related		0.1	0.1	0.1	
Agriculture		0.4	0.4	0.4	
Natural gas T&D		2.0	2.1	2.1	
Landfills, POTWs		6.7	6.0	6.0	Includes out-of-state LFs taking NJ MSW
Released thru land clearing		1.1	1.1	1.1	
Sequestered by forests		-6.8	-5.9	-5.9	
Totals		**135**	**158**	**119**	
1990 estimate	**120**				

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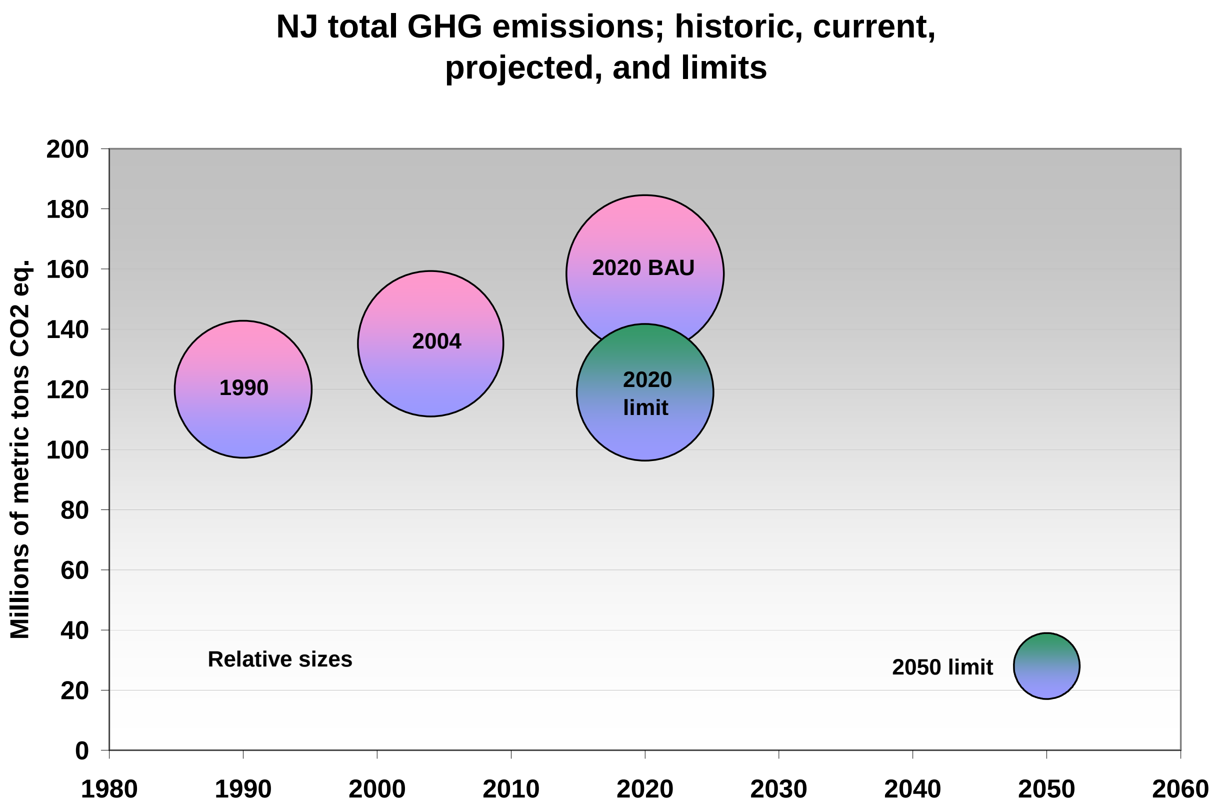
Projections to 2050

Projections beyond the next decade, depicted in Figure 5, carry huge uncertainty. Many factors, such as a major economic downturn, a peaking and then decline of global oil and/or natural gas production, the introduction of currently unknown technology, etc. could change the picture greatly.

Figure 5



Nevertheless, it appears that the 2050 limit will require a degree of reduction that is far more pronounced than will be necessary to achieve the 2020 limit. At least for some sectors, major new initiatives or technologies will likely be required. An example is the transportation sector; long-term reductions in emissions will require additional significant improvements in fuel efficiency or dramatic reductions in vehicle miles traveled, or both.